REMARKS

The amendments to claims 1 and 2

The amendment to claim 1 replaces the claim term "the value of the" with --the determined-- and thereby solves the antecedent problem posed by "the value of the". The "determined modulation index[es]" are obtained by comparing plots such as those shown at 213 which are produced by the CPT frequency standard with the theoretically determined plots for various modulation indexes which are shown in FIGs. 4A-4G. The amendment to claim 2 corrects a typographical error.

The election of claims 1-15

As indicated above, Applicant amended his claims to overcome the restriction requirement and explained in the *Response* to the restriction requirement why the claims as amended overcame the restriction requirement. Examiner has entered the amendment made in the *Response*, and consequently, Applicant's explanation of why the claims as amended overcame the restriction requirement is a traversal of the restriction requirement as it applies to the amended claims. MPEP 818.03(a) consequently does not apply and the restriction is petitionable.

Traversal of the rejection of claims 1-10 under 35 U.S.C. 112, 2. paragraph as vague and indefinite

This is in fact a rejection of claim 1, since claim 1 is the only claim which has the language complained of, with the rejection of the rest of the claims being based solely on the fact that they are dependent from claim 1. What is being set forth by the claim language which Examiner deems to be "vague and indefinite" is that "the determined modulation index [is] subsequently employed to calibrate the laser source to run at the desired modulation index". The process in which "the determined modulation index [is] employed" is clearly set forth in the limitation as "calibrat[ing] the laser source to run at the desired modulation index". Applicants' *Specification* discloses a number of techniques for employing the determined modulation index "to calibrate the laser source to run at the desired modulation index". Since that is so, the limitation is fully supported

by the *Specification* as filed, and because the limitation clearly sets forth the process in which "the determined modulation index [is] employed", the rejection under 35 U.S.C. 112, 2. paragraph is without basis.

The rejection for lack of enabling disclosure under 35 U.S.C. 112, 2. Paragraph

As set forth at [0014] of Applicant's Specification, the problem solved by Applicant's techniques is the following:

> A problem in making frequency standards 101 has been that the standard technique for determining the modulation index of light 105 produced by a laser has been the need to remove the laser from the frequency standard and/or use a specialized optical spectrum analyzer to determine the laser's modulation index. Under even the best of circumstances, this procedure is time consuming and fraught with all of the risks involved in removing and reinstalling a component of a precision device. However, one of the great advantages of frequency standards like frequency standard 101 is their small size; current versions in which the whole device is 7 cm. long have been produced and versions which are 4.2 mm long and 1.5 mm square, and thus small enough to be a component of an integrated circuit, are under discussion. As the frequency standards become smaller, it becomes ever more difficult and finally impossible to remove the laser to determine its modulation index.

The techniques are described in overview at [0016] as follows:

> In the general technique, the laser light is modulated at a given power and a given frequency and then passes through the alkali metal vapor cell. The modulation index is then determined from the absorption spectrum of the light that has passed through the alkali metal vapor cell. The absorption spectrum includes a number of minima and the modulation index is determined from the minima. The minima may be detected by the photodetector.

[0028]-[0033] set forth the physical principles that the technique takes advantage of. Plot 201 of FIG. 2 shows the effect on photodetector output signal 115 of the frequency standard 101 "if the wavelength of an unmodulated laser is slowly swept across the hyperfine resonances of the D1 line of rubidium 87." [0030]. Plot 213 "shows the effect on photodetector output signal 115 if laser source 103 is modulated at approximately ½ the hyperfine separation 153 shown in FIG. 1 and is then slowly swept across the hyperfine resonances as described above". [0031]. As pointed out at [0012], "In system

101, the two frequencies necessary to produce the CPT are produced by modulating the current source of laser 103 at a microwave frequency which is ½ of frequency 153", i.e., plot 213 shows the effect on the photodetector output signal when system 101 is being operated as required to produce the CPT. The meanings of experimental plot 213's minima are explained at [0032]:

> Experimental plot 213 is in principle the result of the convolution of the modulated laser spectrum with the hyper-fine absorption spectrum. The deepest minimum is at R 219, and this dip is the result of the absorption of laser light 105 by transitions caused by the two first sidebands J 1 + and J 1-; it will be termed in the following the primary minimum. The other dips are termed satellite minima; they are the result of the absorption of laser light 105 by transitions caused by combinations of the sidebands and of the carrier. Thus, S1 217 corresponds to sideband 2 307 and carrier 303; S2 215 corresponds to sideband 3 209 and sideband 1 305. As will be explained in detail in the following, the current modulation index of laser light 105 may be determined from either the ratio of the value of plot 213 at primary minimum R 219 to the value of plot 213 at satellite minimum Sl 217 or the ratio of the value of plot 213 at satellite minimum Sl 217 to the value of plot 213 at satellite minimum S2 215.

As set forth at [0033], because the minima of experimental plot 213 have these meanings, they can be used to determine the current modulation index of laser light 105 without removing laser 103 from frequency standard 101 or having to use a special optical instrument. Moreover, as also set forth there, "the power of the signal by which laser 103 is modulated may be modified in a way that produces the modulation index required for the best performance of frequency standards of the type of frequency standard 101. One way of doing this is manually; another is to have control processor 121 do it automatically".

Enabling disclosure of the manual method

The manual method is described beginning at [0034]. As set forth there,

> If plot 213 produced by the modulation index that gives the best performance of frequency standard 101 is known, plot 213 produced by the current modulation index can be compared with the plot for the desired modulation index, and microwave generator 127 can be hand adjusted in the direction required to achieve the desired modulation index.

FIGs. 4A-4F show a set of theoretically-determined plots for various modulation indexes. Each of the plots includes the modulation index it is for at the top of the plot. What the desired modulation index is depends of course on the situation; for CPT frequency standards, the modulation indexes of 1.8 (FIG. 4C) and 2.4 (FIG. 4E) are "interesting" for the reasons set forth at [0035]. Thus, with hand adjusting, if the modulation index of interest is 1.8, microwave generator 127 is adjusted until plot 213 produced by the CPT frequency standard looks like the theoretical plot for modulation index 1.8 shown in FIG. 4C. For details, see [0036]. As set forth at [0034], with this kind of hand adjustment, the actual modulation index can be adjusted to within about 10% of the most desired value.

As may be seen from the foregoing, Applicant's Specification clearly sets forth how claim 1's "desired modulation index" may be determined, how the "modulation index of the laser source may be determined from the absorption spectrum of the alkali metal vapor", and how this "determined modulation index" may "be employed to calibrate the laser source to run at [the] desired modulation index". See in this regard the summary of the manual method at [0037]. The Specification thus provides an enabling disclosure of claim 1 and the rejection of claim 1 as failing to comply with the enablement requirement is without basis. Examiner will immediately see that the arguments made above with regard to claim 1 apply equally to dependent claim 10, claim 11, and dependent claim 12

Enabling disclosure of the automatic method

[0037] also provides a summary of the automatic method:

> Automatic adjustment of the index of modulation can be done if a characteristic of feedback signal 117 exists from which control processor 121 can determine how the current modulation index needs to be adjusted to obtain the desired modulation index. An important aspect of the present invention is the discovery of such a characteristic and its use. The characteristic of feedback signal117 which is employed in the invention to determine how the current modulation index needs to be adjusted is the following: the current modulation index varies with the ratio of R 219 to Sl 217 or with the ratio of Sl 217 to S2 215; thus, either of these ratios Rl/Sl or Sl/S2 can be used by control processor 121 to adjust the power of the modulating signal and thereby the modulation index.

The manner in which the automatic method is implemented in the preferred embodiment is disclosed at [0038]-[0048]. [0038] discloses the relationships between the minima of graph 601 and further sets forth how the ratios R1/SI and S1/S2 may be ambiguous with regard to the modulation index, but how the ratios may be disambiguated using the S3 minimum. [0039] discusses FIG. 5, which shows how control processor 101 may be set up to perform the automatic method. [0040]-[0047], finally, set forth an algorithm for doing the automatic method in control processor 101 when it is set up as shown in FIG. 5. [0048] describes when the automatic method may be performed.

The automatic method provides a second enabling disclosure of the methods of claims 1 and 11 and further provides enabling disclosures of dependent claims 2-9, 12, 13-15. Since the Specification as filed provides enabling disclosures of all of claims 1-15, Examiner's rejection of those claims under 35 U.S.C. 112, paragraph 2 as lacking enablement is without basis.

The rejection of claims 1-15 as anticipated by U.S. Patent 6,320,472, Vanier, *Atomic frequency standard*

As set forth in Applicants' [0013], a problem with the atomic frequency standard disclosed in U.S. Patent 6,320,472 is that the laser has to be removed from the atomic frequency standard and/or tested with a specialized optical spectrum analyzer to determine the laser's modulation index. The need either to remove the laser from the atomic frequency standard or to use a specialized optical spectrum analyzer is eliminated by Applicant's technique of "determining the modulation index of the laser source from the absorption spectrum of the alkali metal vapor". This limitation is present in both independent claim 1 and independent claim 11 and is not disclosed in 6,320,472; consequently, 6,320,472 does not anticipate Applicant's independent claims. It should further be pointed out that the fact that the methods use the absorption spectrum further makes the use of minima and of ratios between the minima to determine the modulation index possible. The use of the absorption spectrum also makes automatic performance of the method possible (claim 12) and permits performance of the method in the operative CPT frequency standard (claims 12 and 13).

At the end of his rejection under 35 U.S.C. 102, Examiner attempts an inherency argument: all lasers used in a frequency standard like that shown at 101 would have plots like those shown in 213. The problem with this argument is that what is being claimed is not the plots, but rather the use of the physical phenomena represented by the plots to determine the modulation index of the laser and to use the "determined modulation index' to "calibrate the laser source to run at a desired modulation index" (claim 1) or to calibrate the frequency-modulated laser source as set forth in the method of claim 11. As set forth above, 6,320,472 does not disclose any such technique for calibrating its lasers to run at a desired modulation index.

Conclusion

Applicant has amended his claims to solve typographical and antecedent problems, has demonstrated that the amended claims are supported by the Specification as originally filed, has clarified that their election of claims 1-15 was with traversal, and has traversed Examiner's rejection of claims 1-10 under 35 U.S.C. 112 first paragraph, claims 1-15 under 35 U.S.C. 112, second paragraph, and claims 1-15 under 35 U.S.C. 102 as anticipated by 6,320,472. Applicant has thus been completely responsive to Examiner's non-final Office action of 1/14/2010 and has thereby satisfied the requirements of 37 C.F.R. 1.111(b). Applicant consequently respectfully requests that Examiner continue with his examination as specified by 37 C.F.R. 1.111(a) and allow the claims as amended. No fees are believed to be required for this amendment. Should any be, please charge them to deposit account number 501315.

Respectfully submitted,

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